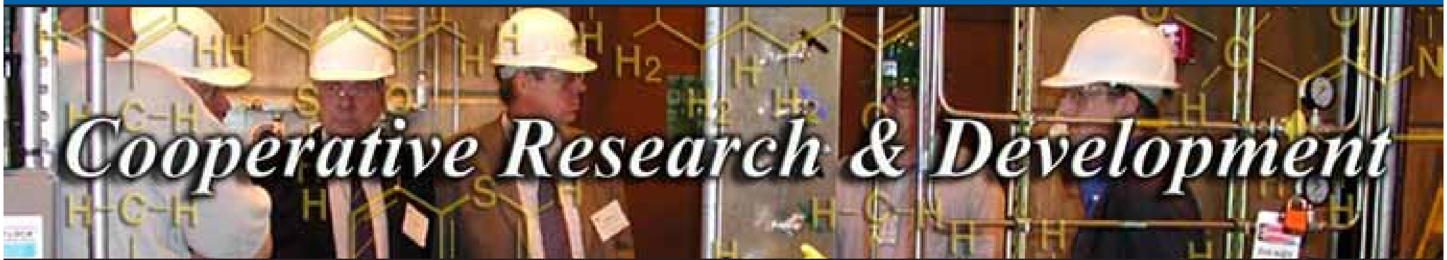

Successes

Sorbent Enhancement Additives for Mercury Control

Advanced Research

To support coal and power systems development, NETL's Advanced Research Program conducts a range of pre-competitive research focused on breakthroughs in materials and processes, coal utilization science, sensors and controls, computational energy science, and bioprocessing—opening new avenues to gains in power plant efficiency, reliability, and environmental quality. NETL also sponsors cooperative educational initiatives in University Coal Research, Historically Black Colleges and Universities, and Other Minority Institutions.

Accomplishments

- ✓ **Process innovation**
- ✓ **Cost reduction**
- ✓ **Greater efficiency**
- ✓ **Environmental benefits**

Description

Utilities need technologies that can provide reduction of mercury emissions in a manner that is cost-effective, is applicable to their various plant configurations, and can provide high levels of mercury control with minimal impacts on plant operations. Because mercury can be present in the gaseous form as either oxidized mercury or elemental mercury, any effective control strategy must optimize control of both. Plants firing low-rank coals, especially lignite, are considered to have the most problematic and/or challenging mercury capture applications because these coals have low chlorine content, resulting in mercury emissions that are mostly elemental, thereby making capture more difficult. Consequently, for plants that combust lignite and subbituminous coals, technologies that are effective for capture of elemental mercury are needed.

The Energy & Environmental Research Center (EERC) began working with the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) and with industry in the early 1990s to better understand mercury emissions from coal-fired power plants, with the goal of developing effective technologies for control. The EERC sought development of technologies that could be applied by the utility industry to effectively reduce mercury emissions and address economic, environmental, and regulatory objectives. Development efforts focused on technologies that were cost-effective and that could be easily integrated, taking advantage of existing air pollution control devices, e.g., electrostatic precipitators (ESP), fabric filters, and flue gas desulfurization systems.

With support from NETL, the EERC has been successful in developing, testing, and demonstrating a number of mercury control technologies while working with utilities and coal companies throughout the United States and Canada.

Technology Approach

Mercury (Hg) and other trace metals are captured to some extent by existing particulate control devices and flue gas treatment systems that are used throughout the industry for control of multiple pollutants, including nitrogen oxides (NO_x) and sulfur dioxide (SO_2). However, while these devices may be quite effective at removing mercury from plants that fire high-rank eastern bituminous coals, they are not typically effective for mercury control in plants that combust lower-rank lignite and subbituminous coals. As already stated, low-rank coals generally produce emissions that are primarily elemental mercury, which is more difficult to control. Early tests showed that activated carbon (AC) was somewhat effective at capturing mercury for these coals but was, in most cases, limited to about 60 percent removal, regardless of how much AC was injected (1). Several projects using subbituminous and lignite coals showed less than 50 percent removal using standard ACs, even at injection rates exceeding 10 lb/Macf, a level considered uneconomical and unacceptable by most utilities.

PROJECT DURATION

Start Date
02/02/02

End Date
12/31/07

COST*

Total Project Value
$5,132,081

DOE/Non-DOE Share
$1,903,219 / $3,228,862

* These funds were from six cooperative R&D projects of varying durations and costs. See table at bottom of next page.

INDUSTRIAL PARTNERS

Energy & Environmental Research Center (EERC) Grand Forks, ND

Alliant Energy Corporation

ALSTOM Power

AmerenUE and Services

American Electric Power

Associated Electric Cooperative

Babcock & Wilcox Company

Basin Electric Power Cooperative

BNI Coal Ltd.

Detroit Edison Electric (DTE Energy)

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Westmoreland

To overcome this limitation, the EERC developed a sorbent enhancement additive (SEA) technology that significantly improves the reactivity of AC, thereby making it much more effective at capturing both elemental and oxidized forms of mercury. The technology can also improve native capture by existing fly ash and can improve oxidation for subsequent removal by downstream SO_2 control systems.

The following are some key advantages that EERC-developed SEA technology offers:

- Improves native mercury removal by fly ash.
- Improves mercury oxidation, which can improve capture in downstream equipment.
- Allows use of more abundantly available supplies of AC (treated ACs have limited supply).
- Improves mercury capture while using far less AC.
- Improves mercury capture efficiencies, in some instances, to greater than 90 percent (standard ACs can be limited to around 60 percent).
- Allows for performance and cost optimization of SEA and AC at each site.
- Minimizes ESP particulate and opacity problems by using lesser amounts of AC.
- Minimizes fabric filter particulate emissions and pressure drop, while allowing the unit to operate at maximum load, by using lesser amounts of AC.

Through significant testing at many power plant test sites, the SEA technology has consistently shown that significantly less AC can be used when combined with SEAs, providing better economics and fewer potential balance-of-plant impacts. In most cases, the amount of AC can be decreased by a factor of 2–4, yet provide higher levels of mercury capture. The SEAs are abundant and affordable, resulting in improved economics as compared to using high injection rates of AC or commercially available treated carbons.

Performance and cost advantages were demonstrated at the Antelope Valley Station in North Dakota, shown in Figure 1. The 440-MW unit that was tested combusts a Freedom lignite coal and is equipped with a spray dryer and fabric filter; in an uncontrolled state, this unit emitted mercury that was found to be over 85 percent in the elemental form.

EERC LH31871

Figure 1 – Antelope Valley Station, near Beulah, North Dakota.

During the tests, a standard commercially available AC was used with and without the SEA technology. As seen in Figure 2, the use of the SEA technology significantly improved mercury capture to over 90 percent while injecting approximately 1 lb/Macf of AC, as compared to less than 50 percent capture at the same injection rate of AC without the use of SEA. Additionally, without the use of the SEA technology, the capture efficiency was limited to less than 70 percent, regardless of the amount of AC that was injected. Similar improvements have been seen at plants equipped with ESPs.

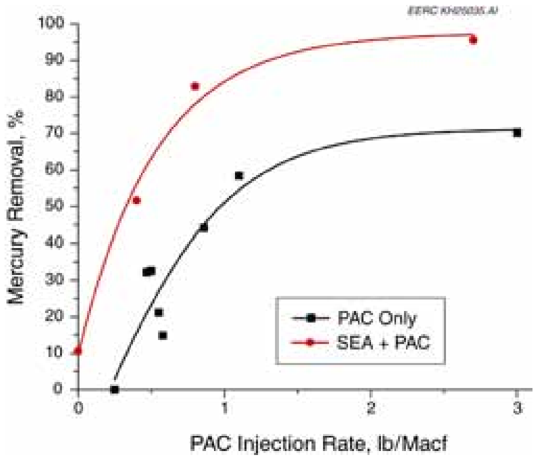

Figure 2 – Synergistic effect of SEA plus standard powdered AC (PAC) during testing at the Antelope Valley Station.

Commercial Applications

The SEA technology has been successfully tested at the bench-, pilot-, and full-scale levels for coal-fired utilities, with promising results. Although developed initially to reduce mercury and enhance capture in coal-fired power plants, the technology has applicability to many other industrial uses. For example, the cement industry is presently facing regulations, and this technology, in one of its variants, is likely to facilitate better capture in existing control devices, including ESPs, selective catalytic reduction units, fabric filters, and flue gas desulfurization units, with very low capital investment. Because the technology can be adjusted to meet the specific flue gas environment easily, mercury control can be optimized, yielding favorable economics with minimal environmental impact. The SEA technology is available commercially.

References

1. Feeley, T.J., III; Murphy, J.T.; Hoffmann, J.W.; Granite, E.J.; Renninger, S.A. "DOE/NETL's Mercury Control Technology Research Program for Coal-Fired Power Plants." *EM-Environmental Manager* **2003**, 16–23.

Projects Included

Project Title	Duration		Cost		
	From	To	Total	DOE	Non-DOE
Mercury Control Technologies for Electric Utilities Burning Lignite Coals – Phases I & II (JV 45)	02/02/02	12/31/07	$1,933,000	$773,000	$1,160,000
Pilot-Scale Testing of Potential Mercury Control Technologies for TXU (JV 71)	01/01/04	08/31/05	$432,018	$151,262	$280,756
Mercury Control Technologies for Electric Utilities Burning Subbituminous Coals (JV 73)	01/01/04	01/31/06	$750,000	$262,740	$487,260
Investigation of the Mercury and Carbon-Based Sorbent Reaction Mechanisms (JV 78)	07/01/04	03/31/07	$133,870	$46,870	$87,000
Assessment of Mercury Control Options and Ash Behavior in Fluidized Bed Combustion Systems (JV 82)	01/01/05	09/30/07	$816,831	$296,153	$520,678
Large-Scale Testing of Enhanced Mercury Removal for Subbituminous Coals (JV 88)	05/01/05	12/31/06	$1,066,362	$373,194	$693,168

"Through significant testing at many power plant test sites, the SEA technology has consistently shown that significantly less AC can be used when combined with SEAs, providing better economics and fewer potential balance-of-plant impacts … The SEAs are abundant and affordable, resulting in improved economics as compared to using high injection rates of AC or commercially available treated carbons."

States and Localities Impacted

Palo Alto, CA

Colorado Springs, CO

Windsor, CT

St. Louis and Springfield, MO

Columbus, OH

Worcester, MA

Detroit, MI

Elk River, Fergus Falls, and St. Paul, MN

Bismarck, Grand Forks, and Underwood, ND

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